SENIOR THESIS

A Determination of Ice Accumulation Rates on The West Antarctic Ice Sheet Marie Byrd Land, West Antarctica

by
David Joseph White
1987

Submitted in partial fulfillment of
the requirements for the degree of
Bachelor of Science
in Geology and Mineralogy
at The Ohio State University,
Autumn Quarter, 1987

Approved by:

I. M. Whillans

Dr. Ian M. Whillans
Senior Thesis Advisor

TABLE OF CONTENTS

I. ABSTRACT

Net accumulation rates for sites on the West Antarctic Ice Sheet in Marie Byrd Land, West Antarctica are calculated based on the interpretation of nuclear bomb fallout horizons and ice core drilling data. Fallout horizons within the ice cores are correlated with known beta-particle activity levels deposited in Antarctic ice during the austral summers of 1954-55 and 1965-66. A BASIC program calculates the depth of the fallout horizons utilizing a database of field drilling logs. The program calculates an ice-equivilent height for the snow column above the "bomb" core sample and divides this ice column height by the age of the fallout horizon to determine the accumulation rate.

An error analysis was performed to determine the effect on accumulation rate by measurements of core sample size, mass and the interpretation of fallout horizon histograms. These calculations show that the determination of ice accumulation rate changes in direct proportion to changes in measurements of the core sample's length, mass, or the precise identification of the fallout horizons. Changes in measurements of the core diameter doubly affect the accumulation rate.

Accumulation rate varies locally, but a regional trend is observed in that the rate generally appears to increase with increases in elevation, local surface slope and distance from coastal regions.

II. ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Ian M. Whillans both for his role as an employer and for his patience as an advisor in dealing with my many questions and problems in the course of this project.

I would also like to thank Tiffany Gentry for recommending that I work for Dr. Whillans and for her work in core processing. Additionally I would like to mention the frequent help given to me by Mike Gibbons, Patricia Vornberger, Mike Strobel, Lynn Lay and the other members and staff of the Byrd Polar Research Center.

Portions of this work were funded by Dr. Whillans' National Science Foundation Grant # DPP-8117235 and a grant from the Federal Work-Study Program.

III. LIST OF FIGURES

IV. LIST OF TABLES

V. INTRODUCTION

The West Antarctic Ice Sheet (W.A.I.S.) occupies a region of more than 1.97 Million km^2 between the Ross and Weddell Seas and the Transantarctic Mountains (see figure 1.) Most of the ice sheet is grounded on the Antarctic continent in basins which lie below sea level. The marine nature of the ice sheet and its possible instability have been the subject of extensive scientific study and debate. Mercer (1976) suggested that marine ice sheets are inherently unstable and precariously sensitive to fluctuations in sea level and climate. Numerous authors (Mercer, 1968; Hughes, 1973; Thomas and Bentley, 1978; etc.) have hypothesized that an increase in sea level or a climatic warming could ultimately raft much of the W.A.I.S. A rafting of the ice sheet, breaking the bond between the ice and the underlying bed, would result in an inland advance of the ice sheet's grounding line. The grounding line is, more accurately, a narrow zone where the ice sheet separates from the bed and begins to float on sea water as an ice shelf. A rapid inland advance of the grounding line could flood much of the sub-sea-level continental bed, greatly reducing the frictional drag exerted on the ice sheet by the bed. The removal of this great pinning resistance would result in an increase in ice flow to the Ross and Weddell Seas, possibly triggering the total collapse of the ice sheet. The collapse and subsequent melting of the 1.5-1.8 Million km^3 West Antarctic

Ice Sheet could result in a worldwide increase in sea level of almost five meters. Evidence of the occurrence of a similar event in the past was described in a discussion of the Sangamon sea level and relic beach benches by Mercer (1968.)

The potential for devastation of coastal regions throughout the world and the possible acceleration of climatic warming due to recent anthropogenic influence has prompted numerous investigations to determine the stability of the W.A.I.S. The first step is to determine its current behavior or mass balance. Mass balance is a quantitative comparison of the input and output of a glacial system. Output is by melting, iceberg calving, evaporation and sublimation. Input depends on the area of recharge and the rate of ice accumulation within that region.

In 1983 the West Antarctic Ice Sheet became the focus of a major scientific study. The West Antarctic Ice Sheet Project (W.I.S.P.), sponsored by the National Science Foundation and involving teams from The Ohio State University, The National Aeronautics and Space Administration, The University of Chicago and The University of Wisconsin began with the determination of the ice sheet's mass balance stated as one of the primary goals of the project. The complexity of the project mandated a division of labor, with numerous subprojects being directed by several principal investigators. The execution of these subprojects was a collaboration of efforts on the part of all of the member institutions. The determination of ice accumulation rates and ice stream velocities was undertaken by Dr. Ian M. Whillans of The Ohio State University's Institute of Polar Studies (now The Byrd Polar Research Center.)

During Antarctic field seasons in the 1983-84, 1984-85 and 1985-86 austral summers, teams under Dr. Whillans' direction retrieved hundreds of meters of hard-augured ice (firn) cores for processing in the Institute of Polar Studies' cold rooms.

In 1986 the author was employed by Dr. Whillans to process a portion of the 1984-85 and 1985-86 core samples. The task of core processing later evolved into assisting with the development of a computer program to facilitate the determination of ice accumulation rates. Additionally, the importance of these accumulation rates in the mass balance calculations required that an assessment of the influence of input parameters on accumulation rates be performed to determine the level of confidence placed in them. The author's resultant familiarity with the project prompted Dr. Whillans to suggest that the author complete a summary of that portion of the project in order to fulfill the senior thesis requirement for the Bachelor of Science degree in Geology and Mineralogy at The Ohio State University.

VI. THE WEST ANTARCTIC ICE SHEET PROJECT (W.I.S.P.)

The two kilometer thick West Antarctic Ice Sheet is drained by several major ice streams which flow from surface elevations of greater than 2000 meters in their catchments to nearly sea level at the Ross, Ronne and Flichner Ice Shelves. Ice streams are regions within the ice sheet, which for reasons yet to be determined, flow at rates about one hundred times faster than the surrounding ice. The dynamic nature of the ice streams has been the focus of the (W.I.S.P.) project because understanding their behavior is seen as crucial in determining the stability of the entire ice sheet.

Preliminary radar soundings of the ice streams of Marie Byrd Land, designated "A", "B", "C", "D" and "E", were performed by geophysicists from Cambridge University's Scott Polar Research Institute in 1974 (Rose, 1979.) Interpretation of their results later determined on which of the five ice streams the Ohio State team would concentrate its study. The selection criteria included a relatively simple bed topography and flow conditions which seemed to be typical. Ice stream "A" was eliminated from consideration due to its proximity to and influence of the Transantarctic Mountains. Radar soundings of Ice Stream "C" revealed a complex crevasse network, typical of all of the ice streams, but overlain by a relatively unbroken snow layer. This layer obviously had not been disrupted by the rapid flow typical of ice streams, suggesting that this one had recently become stagnant. Radar soundings of the remaining three ice streams indicated that Ice Stream "B" had the simplest bed topography. After a review of this research Dr. Whillans selected Ice Stream "B" as the focus of the W.I.S.P. mass balance study.

The W.I.S.P. field program was designed to take place over several years with specific goals for each successive austral field season determined from both a long range plan and the analysis of the preceding year's data. The master plan called for gridded networks of stations to be established over the course of several field seasons. These grids, oriented both longitudinally and transversely to the flow of the ice streams, would serve several functions. Station points within the grids were positioned on the ice stream itself, its heavily crevassed margins, the catchment area and the stagnant ice ridges which separate the ice streams. The stations provided photogrametric ground control for aerial photography used to compute flow velocities. These velocities were used in the construction of flow nets which define the lateral extent of the ice streams, delineating its catchment or recharge area. The control stations also served as the sites of local strain grid studies and ice core sampling.

A semi permanent camp (Camp "UPB") was established on Ice Stream "B" in November, 1983. This site functioned as a base for excursions to more remote regions of the ice stream and the surrounding region. Teams of two to four members would be flown by a ski-equipped Twin Otter aircraft to a selected control station. The team would install a satellite receiver (Magnavox MX-1502 or JMR-1) at the station, leaving it in place for approximately 24 hours. The receiver would, in that period, calculate the site's x, y and z polar grid coordinates, longitude and latitude based on the passing of TRANSIT satellites. After installation of the receiver and aerial photo targets the team moved to another station, repeated those tasks and drilled an eight-meter ice core. By this method each team was routinely able to install two satellite receivers and recover one ice core in a single field day. Each site was revisited during the following field season for another satellite positioning and replacement of the aerial photo targets. Ice cores were to be taken from each site only once during the project unless analysis at Ohio State's Columbus facility proved difficult, requiring an additional core for comparison.

Ice core drilling at each site was to proceed to a depth of at least eight meters. A PICO or SIPRE 3" ID hand auger was used to recover core samples. The drilling method consisted of the manual insertion of the drill stem and augering to no more than one-half the drill barrel length prior to withdrawal. Upon removal of the drill stem the core sample would be removed. After every second or third drill insertion (drilling run) the drill stem was fitted with an additional stem attachment. The process would then be repeated until the eight meter depth had been reached. A drilling log was maintained to later determine the exact depth of origin for each sample removed. After removal from the drill stem the recovered core was measured for length, diameter and weight. These samples were then cut into approximately ten centimeter lengths, measured, weighed, placed in sequentially numbered plastic bags and packaged for transport to Camp "UPB." At Camp "UPB" the core sample bags were heat-sealed and packed in freezer boxes for shipment via refrigerated ship and truck to the Institute of Polar Studies' cold rooms in Columbus, Ohio.

VII. CORE PROCESSING AND ACCUMULATION RATE DETERMINATION

Upon arrival at the Institute of Polar Studies, in Columbus, Ohio, the boxed core samples were placed in the Institute's cold storage facility. Inspection and processing (measurements of mass, length and diameter) of the samples were performed in a refrigerated laboratory (-10 degrees Celsius.) After these initial measurements were completed the samples were placed in individual polyethylene containers and allowed to melt at room temperature (22 degrees Celsius.) These liquid samples were processed for beta-particle activity in a method similar to that of Delmas and Pourchet (Whillans and Bindeschadler, 1987.) Prior to melting the samples were treated with four molar hydrochloric acid at a rate of one microliter of HCL per 100 grams of sample. This procedure retarded the adsorption of the radioactive isotopes, predominantly ^{137}Cs and ^{90}Sr, from the meltwater to the containers. The melted samples were pumped through acid-activated cation-exchange filters for a period of at least one hour at a rate of about liters per hour. After filtration the wetted filters were placed on racks to dry and left undisturbed for a period of twenty-four hours. This allowed the stabilization of the isotopic species captured on the filters during the filtration process. The beta-particle emission activity of the isotopic species captured on the filters was measured using a CANBERRA gas-flow proportional counter equipped with a cosmic guard and lead brick enclosure.

Drilling logs, laboratory measurements and beta-particle emission activity data were entered into a PC database using BASIC programs written by Dr. Whillans. One of these programs, Lab3, produced histograms of relative Beta-particle emission. Histograms were generated following the initial-stage processing of every fifth sample in a core. These preliminary graphs revealed the approximate location of the nuclear fallout horizons in the core to within twenty-five centimeters (based on an average sample length of ten centimeters.) After every fifth sample in a core had been processed, samples surrounding suspected fallout horizons were processed in order to more accurately determine the horizon locations within the core. By this method the histograms of every fifth sample were selectively "filled in" only around the suspected radioactive peaks (see figures 3A, 3B and 3C), keeping core processing to an economical minimum. In only a few cores, where bomb horizons were difficult to discern, was the entire eight meter core processed.

Nuclear fallout horizons within the cores were determined on the histograms using guidelines established by Joulet (Whillans and Bindschadler, 1987) for the broad (beta) activity peak of the 1964-65 austral summer and the (beta) activity increase of the 1954-55 austral summer. After final determination of the bomb horizons by Dr. Whillans, the "bomb" sample numbers were entered into a BASIC program written by Dr. Whillans and the author. This program, CORE4 (see appendix for code), accesses the drilling and laboratory databases and generates several parameters important to the mass balance calculations. These include an accurate determination of the depth of each sample, a density profile for each core, the mass of the core above a sample (a depth-integrated density), a comparison of field and lab masses, and the accumulation rate. Eventually a comparison of all corresponding laboratory and field measurements may be performed by the CORE4 program, but at this writing the modifications to the code have not been completed.

Input of a bomb horizon sample number and the age of that horizon generates the accumulation rate. The rate of accumulation is determined by the division of the height of the ice column above the sample by its age. Glacial snow undergoes metamorphism with time, burial and the resultant loading of the overlying snow column. This process can continue until the snow has been completely transformed into ice. The CORE4 program dealt with the resulting densification with depth by computing an ice-equivalent length for each firn sample based on its density. A comparison of the drill penetration versus the core recovery was performed for each drill run of each core. Discrepancies in this comparison were dealt with by the simulated "insertion" of "core loss" into the computer drill log (see

Tables 2A, 2B and 2C) assigning it a density based on the average of the densities of the drill runs above and below the site of "insertion." If the comparison revealed "gains" in core, indicating that the length of the recovered core was greater than the depth of the borehole, the program signaled a warning to the program user that a review of the databases and/or drilling logs was necessary.

The maximum and minimum values of sample recovery depth, each containing the maximum or minimum amount of core loss "insertions" respectively, determined a range which provided error limits for all calculations based on sample depth. The variation in values represented by the ranges rarely exceeded ten percent. Because of this close agreement, the ranges of values were presented as the average of the maximum and minimum unless their difference exceeded ten percent.

VIII. ERROR ANALYSIS

The importance of the accumulation rate in the W.I.S.P. mass balance calculations required that an analysis of measurement errors be performed for all input variables. This analysis was facilitated by the manipulation of variables within the CORE4 computer program. First, a duplicate database for a given core was created. Then a sequence of program runs was performed on the duplicate database employing a range of values for the input parameters. This allowed the generation of accumulation rates influenced by controlled variations of input. The resulting accumulation rates were then compared with those generated with the original input parameters to determine whether or not the changes in input variable created significant changes in the accumulation rate.

The accumulation rates generated in the manipulation scheme closely agree with the results of a standard error propagation analysis used by Whillans and Bindschadler (1987.) This formal and more elegant approach to the error analysis is based on the equation for accumulation rate:

1 $$b = (4/\pi)(M/\phi^{2}),T.$$

where b is the net ice accumulation rate, M is the sum of the sample masses above a fallout horizon, ϕ is the diameter of the sample and T is the age of the fallout horizon. Taking the first partial derivative of # 1 with respect to each parameter gives the general derivative of the accumulation rate equation (#1):

$$\# 2 \qquad db'/b' = dM/M - 2d\phi/\phi \;\; -dT/T.$$

This derivative shows that the accumulation rate is directly proportional to changes in mass (M) and time (T). Changes in diameter (ϕ) result in twice that change being reflected in the accumulation rate.

Due to the sensitivity of accumulation rate determination to changes in core diameter, measurements of diameter were made both in the laboratory and the field. Often under time and weather constraints, field assistants did not systematically measure the diameter of the recovered core. In some cases, only a few measurements were made and those values assigned to an entire core; in others, no measurements of diameter were made. In the laboratory, obtaining good measurements of core diameter was made frustrating due to the partial sintering (melting) and breakage of the highly friable samples.

Variations in the field measurements of diameter were statistically analyzed. In twenty-seven out of fifty-two core logs the diameter fluctuates, these appear to have been measured conscientiously. This population of cores had an average diameter of 75.97 millimeters with an average standard deviation of 1.49 mm (about 2%). This statistic indicates that a diameter of 76 mm would be highly representative for that portion of the core population. In equation # 2 it was shown that any change made in the diameter of a core would affect a change of twice that magnitude on the accumulation rate. Variations of plus or minus the standard deviation on the mean diameter yield an uncertainty of about 2% in those cores for which diameters were accurately measured.

Field crews and laboratory assistants sometimes failed to measure core diameters at all, this is evident from drilling logs which record only one value for diameter. The mean statistical diameter, from those cores which were measured, was applied to the remaining cores. This places an uncertainty of 0.9 mm on the diameters of cores which were not actually measured. Accumulation rates generated for these sites were compared for consistency with those of neighboring sites. No major anomalies in accumulation rate were apparent.

The mass of the core samples was shown in equation # 2 to have a directly proportional influence on accumulation rate. Due to lack of confidence in the reliability of the spring balances used to weigh samples in the field, a subroutine has been written into the CORE4 program to compare the laboratory and field sample masses (see the columns labeled "% larger for lab masses" in figures 3A, 3B and 3C.)

This simple comparison of masses has been complicated by a change made in the core processing method. Preliminary calculations of the effect of precise fallout identification on accumulation rate led Dr. Whillans to allow the processing of "doubled" samples. By processing two samples as one the efficiency of processing was doubled while fallout horizon identification, and ultimately accumulation rate, was only negligibly effected. This created no problem until it became evident that sequentially numbered samples often belonged to different drilling runs. Many of the doubled samples were weighed as one, leaving no record of the mass of some individual samples. An interpolation scheme could be written into the program to approximate those sample weights, but would be a labor intensive effort of negligible worth. Sample masses measured in the laboratory are consistently less than ten percent smaller than those masses obtained in the field. This may be due to the sawing of the samples into the easily handled ten centimeter lengths. This relation reveals that the mass input in the accumulation rate calculation is consistent.

The input value of the time parameter in equation # 1 is determined based on the identification and correlation of the nuclear fallout horizons. Interpretation of the histograms of gross beta-particle activity was often subjective due to secular and geographic variations in fallout concentrations. Almost all of the cores contained at least the 1965-66 fallout horizon. Some cores failed to penetrate the 1954-55 horizon and a few others produced indecipherable histograms. The result was that the 1965-66 horizon was used as the primary time-stratigraphic correlation marker. Cores containing both of the horizons had less of an uncertainty than those with only one. Those cores which contained two easily distinguishable fallout horizons provided a control for determining the geographic consistency in accumulation rate.

A sensitivity analysis of the effect of identification of the fallout horizons on accumulation rate was also determined using the CORE4 program. Program runs were made using "bomb" samples located at known distances above and below the actual fallout horizons for cores having easily determined horizons. The accumulation rates generated by these computer manipulations varied from the accepted values by only ten percent when sample depth was varied over a range of about fifty centimeters. Fifty centimeters represents the average distance between the samples in the initial core processing (refer to page 12) and represents a generous margin for fallout horizon identification. This analysis suggests that the "filling in" of the preliminary gross beta activity histograms is of negligible worth. This finding also agrees with the logic which led Dr. Whillans to permit the processing of the "doubled" samples discussed above.

IX. SUMMARY

Accumulation rates generated by the CORE4 program were plotted on a map (after Shabtaie, 1987, see figure 2) showing the location and elevations of the sampling sites. The values plotted suggest a trend of increasing accumulation rate with increasing elevation. Variations in this pattern may be due to a combination of local surface topography, and both broad-scale geographically controlled and secular weather patterns.

Numerous opportunities for the inclusion of error exist in the determination of accumulation rates. The input parameters with the greatest influence on accumulation rate, as shown in equation # 2, have been statistically considered.

The error limits created by the CORE4 program accounts for errors propagating from sample depth. Sample length was treated in the sensitivity analysis of fallout horizon identification. The influence on accumulation rate due to this input appear to be minimal for lengths of less than one half of a meter.

A comparison of laboratory and field masses has shown that laboratory-obtained masses are generally about 3-6% less than the field masses. This may easily be accounted for by the core lost to the sawing of the larger samples into smaller ones. The close agreement of the two independent measurements indicates that the mass input in the accumulation rate calculation is excellent.

The measurements of core diameter, has been shown to have the greatest influence on accumulation rate of all the input parameters. Because nearly half of the recovered core samples are lacking measured diameters the accumulation rate generated from those diameters must be suspect. The relatively small standard deviation on the mean diameter, from those cores which were measured, may provide an order of magnitude quantification on this uncertainty. The uncertainty due to diameter would then fall within a range of less than ten percent. This influence is important in about half of the cores, but its occurrence is random and no major anomalies are seen in the plot of accumulation rate (see figure 2.)

The result is that the confidence in all of the important inputs to the accumulation rate have been analyzed. The accumulation rates generated from these input parameters may be entered into mass balance calculations with a relatively high level of confidence in their accuracy.

X. APPENDIX

CORE4, ACCUMULATION RATE PROGRAM CODE

```
10 SCREEN 0,0,0:PRINT "CORE4 this program interprets raw core-drilling data, det
ermines the  load at depths within the core and calculates accumulation rates":
KEY OFF
20 ' differs form ealier CORE3 in that access is made to a .LAB file
30 ' depths computed based on these criteria:
40 ' 1. core depth can be no deeper than drill depth
50 ' 2. core depth and drill depth are most probably equal where there are
60 '     minima in summed core loss as tested from bottom
70 ' 3. for DEPTH2 suppose that core is most probably lost from the base of a
80 '     run because a piece fell out as drill was withdrawn and then was
90 '     destroyed on the next run
100 '    for DEPTH1 suppose the opposite
105 ON ERROR GOTO 120 : WIDTH "lpt1:",132  ' change max length of line
110 LPRINT CHR$(27);CHR$(56);CHR$(29); :GOTO 122  ' for Henry's printer
115 'LPRINT CHR$(15);CHR$(27);CHR$(48); :go to 122   ' for AT's printer
120 IF ERR=24 THEN PRINT"turn on printer and press F2":END
122 ON ERROR GOTO 0
130 DIM RUNN%(50),LENGTH!(50),FINAL!(50),CORELEN!(50),MASS!(50),SAMPNUM%(50),NAI
VE!(50),CORELOSS!(50),SUMLOSS(50),LOSSRN(30),LOSSRN2(30),DEPTH1(50),DEPTH2(50),D
IAMETER(50)
140 FILES"c:\cores\*.cor":LINECOUNT=0 :PRINT"if it scrolled by too quickly you s
hould have pressed CTRL & NUM LOCK":PRINT"simultaneously, then any key to contin
ue":PRINT
150 INPUT"filename (program adds .COR)";FILE1$ : FILE$=FILE1$+".cor
160 OPEN "c:\cores\"+FILE$ FOR INPUT AS #1 LEN=80 :INDENT=4 : LASTSAMPLE=0
170 INPUT#1,SITE$,MMORTHOUS,DAY$,DATUM'  i.e. mm or thousandths
180 INPUT;"for typed output of drill data ENTER a number, otherwise a null line
";TYPE
190 CLS : IF TYPE=0 GOTO 260 ELSE TYPE =1
200 PRINT "ensure that SEL light on printer is illuminated"
210 LPRINT : LPRINT "file: " FILE$ ",       datum:" DATUM "cm"
220 LPRINT"comment: " SITE$ :LPRINT"data entered on " DAY$ ", CORE3  today's dat
e: " DATE$
230 LPRINT : LPRINT "   drill" TAB(12) "exposed" TAB(23) "recovered" TAB(36) "dr
ill" TAB(47) "apparent" TAB(65) "deepest"
240 LPRINT "  length   portion  core    mass   depth     core loss    run  samp
 No  diam"
250 LPRINT TAB(38) "0.0" TAB(54) "0.0"
260 I=0 : NAIVE!(0)=0! : SUMLOSS(0)=0
270 WHILE NOT EOF(1) : I=I+1 ' read data, calculate naive depths & core loss
280 INPUT#1,RUNN%(I),LENGTH!(I),FINAL!(I),CORELEN!(I),MASS!(I),SAMPNUM%(I),DIAME
TER(I)
290 NAIVE!(I)=LENGTH!(I)-FINAL!(I)
300 CORELOSS!(I)=NAIVE!(I)-NAIVE!(I-1)-CORELEN!(I)
310 SUMLOSS(I)=SUMLOSS(I-1)+CORELOSS(I)
320 IF SUMLOSS(I)<0 THEN PRINT:PRINT "net core gain !":IF SUMLOSS(I)<-1 THEN BEE
P : PRINT"'superior' drillers recovered more core than hole is deep"
330 IF TYPE=0 GOTO 370
340 IF SUMLOSS(I)<-1 THEN LPRINT "net core gain !"' allow 1 cm roundoff in meas
350 LPRINT USING "  ####.#";LENGTH!(I),FINAL!(I),CORELEN!(I),MASS!(I),NAIVE!(I),
CORELOSS!(I),SUMLOSS(I);
360 LPRINT USING " ####";RUNN%(I);:LPRINT"   ";:LPRINT USING " ####";SAMPNUM%(I)
;:LPRINT"    ";DIAMETER(I)
370 WEND
380 IF TYPE<>0 THEN LPRINT : LPRINT : LPRINT "automatic ";' selection of runs
390 SUMLOSSMIN=SUMLOSS(I) : JJ=1 '           for which naive depth is accurate
400 FOR K=I TO 1 STEP -1 ' test from bottom up
410 IF SUMLOSS(K)>SUMLOSSMIN GOTO 440
420 NAIVE!(0)=SUMLOSS(K) 'meaningful only for shallowest run
430 LOSSRN2(JJ)=K : SUMLOSSMIN = SUMLOSS(K) : JJ=JJ+1 'identify runs w/ loss
440 NEXT K : PRINT
450 PRINT"deepest reasonable depth below datum to top of 1st recovered sample ="
 NAIVE!(0)
460 PRINT
470 IF TYPE<>0 THEN LPRINT "special runs selected :";
480 LAB=1:ON ERROR GOTO 1260 :CLOSE#3:OPEN "c:\cores\"+FILE1$+".lab" FOR INPUT A
S #3
490 IF LAB=1 THEN INPUT#3,DUMMY$,DUMMYN,DUMMY$,DUMMYN
500 IF TYPE<>0 THEN FOR J=1 TO JJ : LPRINT LOSSRN2(J): : NEXT J :LPRINT " "
```

```
510 LOSSRN2(0)=LOSSRN2(1) : IF LOSSRN2(JJ)=0 THEN GOTO 530
520 JJ=JJ+1 : LOSSRN2(JJ)=0 ' case that shallowest run was not included
530 INPUT"ENTER depth below datum of top of first recovered sample (cm), this is
 ordinarily zero unless operator recognized that shallow core was not recovered"
 ;NAIVE!(0)
540 IF TYPE><0 GOTO 570 ELSE PRINT:PRINT "  corrected depth  drill   core     ru
n   sample    density    % larger for"
550 PRINT         "   of core base    depth  length          number
   LAB masses"
560 GOTO 610
570 LPRINT " depth to top of first recovered core sample " NAIVE!(0)
580 LPRINT:LPRINT "  corrected depth  drill    core     run    sample    density
  % larger for"
590 LPRINT         "   of core base    depth  length          number
   LAB masses"
600 '
610 CLOSE #2 : OPEN "c:\cores\"+FILE1$+".dep" FOR OUTPUT AS #2 : ZERO=0' transfe
r data
620 LASTDEPTH1=0 : LASTDEPTH2=0'                           to second part of program
630 IF RESPONSE ><0 GOTO 1300
640 FOR K=JJ TO 1 STEP -1' compute corrected depths for each interval betw loss
650 TEMP=LOSSRN2(K)' this is the shallower run number
660 DEPTH1(TEMP)=NAIVE!(TEMP)-SUMLOSS(TEMP)+SUMLOSS(LOSSRN2(K-1))+DATUM
670 IF K=JJ THEN DEPTH1(TEMP)=-SUMLOSS(TEMP)+SUMLOSS(LOSSRN2(K-1))+DATUM
680 DEPTH2(TEMP)=NAIVE!(TEMP)+DATUM
690 IF TYPE><0 THEN LPRINT USING"  ####.#";DEPTH1(TEMP),DEPTH2(TEMP);
700 IF TYPE=0 THEN   PRINT USING"  ####.#";DEPTH1(TEMP),DEPTH2(TEMP);
710 INSERT1=DEPTH1(TEMP)-LASTDEPTH1
720 INSERT2=DEPTH2(TEMP)-LASTDEPTH2
730 IF TYPE=0 GOTO 750 ELSE LPRINT TAB(20);: LPRINT USING"####.#";INSERT1;
740 LPRINT " to" ;: LPRINT USING"####.#";INSERT2;: LPRINT " cm of core loss";
750 IF TYPE=0 THEN   PRINT TAB(20) INSERT1 " to" INSERT2 " cm of core loss";
760 WRITE#2,ZERO,INSERT1,INSERT2     ,DEPTH1(TEMP),DEPTH2(TEMP),ZERO,ZERO
770 LINECOUNT=LINECOUNT+1 :IF TYPE><0 THEN LPRINT "" ELSE PRINT
780 FOR J=TEMP+1 TO LOSSRN2(K-1)
790 IF CORELEN!(J)=0 THEN DENSITY=0 : GOTO 830
800 IF DIAMETER(J)=0 THEN DENSITY=0 : GOTO 830
810 IF MMORTHOUS<0 THEN DIAMETER(J)=DIAMETER(J)*.0254
820 DENSITY=MASS!(J)/CORELEN!(J)/(7.854E-06*DIAMETER(J)*DIAMETER(J))
830 DEPTH2(J)=DEPTH2(J-1)+CORELEN!(J)
840 DEPTH1(J)=DEPTH1(J-1)+CORELEN!(J) : GOSUB 1170
850 IF TYPE><0 GOTO 910
860 PRINT USING "  ####.#";DEPTH1(J); : PRINT" -";
870 PRINT USING "####.#  ";DEPTH2(J),NAIVE!(J),CORELEN!(J);
880 PRINT USING "####    ";RUNN%(J),SAMPNUM%(J);
890 PRINT USING "####.#  ";DENSITY,PERCENT;: PRINT NOTE$
900 LINECOUNT=LINECOUNT+1:IF LINECOUNT<20 GOTO 950 ELSE INPUT"press ENTER to con
tinue";DUMMY:LINECOUNT=0:GOTO 950' stops scrolling
910 LPRINT USING "  ####.#";DEPTH1(J); : LPRINT" -";
920 LPRINT USING "####.#  ";DEPTH2(J),NAIVE!(J),CORELEN!(J);
930 LPRINT USING "####    ";RUNN%(J),SAMPNUM%(J);
940 LPRINT USING "####.#  ";DENSITY,PERCENT;: LPRINT NOTE$
950 WRITE#2,RUNN%(J),CORELEN!(J),CORELEN!(J),DEPTH1(J),DEPTH2(J),DENSITY,SAMPNUM
%(J)
960 TEST =NAIVE!(J)+.3+DATUM
970 IF DEPTH1(J)>TEST THEN PRINT "corrected depth > naive depth, above
980 IF DEPTH2(J)>TEST THEN PRINT "corrected depth > naive depth, above
990 IF TYPE=0 GOTO 1020
1000 IF DEPTH1(J)>TEST THEN LPRINT "corrected depth > naive depth, above
1010 IF DEPTH2(J)>TEST THEN LPRINT "corrected depth > naive depth, above
1020 LASTDEPTH1=DEPTH1(J) : LASTDEPTH2=DEPTH2(J) : NEXT J
1030 NEXT K : IF TYPE><0 THEN LPRINT : LPRINT
1040 PRINT
1050 GOTO 1300 'INPUT"ENTER a null line to go on to loads and accumulation rates
, or a number to try   another version";DUMMY:IF DUMMY=0 GOTO 1300
1060 FOR J=1 TO 30
1070 PRINT"ENTER a run with minimum summed core loss (none for no more)"
1080 INPUT"  (or negative to go on to next phase)";LOSSRN(J)
1090 IF LOSSRN(J)<0 THEN GOTO 1300
1100 IF LOSSRN(J)=0! THEN GOTO 1120' naive depth for base of these runs is
```

```
1110 NEXT J                                        ' taken as correct
1120 LOSSRN(J)=I : LOSSRN(J+1)=0  ' loss can occur at ends
1130 JJ=J+1: FOR J=1 TO JJ : RMAX=LOSSRN(1) : NUMB=1 ' order runs, deepest 1st
1140 FOR K=2 TO JJ : IF LOSSRN(K)<RMAX THEN GOTO 1160
1150 RMAX=LOSSRN(K) : NUMB = K
1160 NEXT K : LOSSRN2(J)=LOSSRN(NUMB) : LOSSRN(NUMB) = 0! : NEXT J : GOTO 470
1170 '............... subroutine to compare mass with LAB-determined masses
1180 IF LAB=0 THEN PERCENT=0:NOTE$="/":RETURN
1190 FLAG2=0: SUMMASS=0: IF LASTSAMPLE>(SAMPNUM%(J)-1) THEN FLAG2=1 :GOTO 1245 '
 case of no new sample for this run
1195 FOR I1=LASTSAMPLE TO SAMPNUM%(J)-1
1200 INPUT#3,NUMBE,LENGTHL,MASS,DUMMY$,DUMMYN,DUMMYN,DUMMYN : IF MASS=0 THEN FLA
G2=1
1210 IF I1=LASTSAMPLE THEN NOTE$="":IF LMASS=MASS THEN NOTE$="?"
1215 IF MASS<0 THEN NOTE$="problem mass"
1220 IF MASS><LMASS THEN SUMMASS=SUMMASS+MASS' check if samples are doubled
1230 LMASS=MASS : NEXT I1 : IF NUMBE><SAMPNUM%(J) THEN PRINT"Lab numbs fouled"
1240 LASTSAMPLE=SAMPNUM%(J)
1243 IF MASS!(J)=0 THEN FLAG2=1
1245 IF FLAG2=1 THEN PERCENT=0 : RETURN
1250 PERCENT=(SUMMASS/MASS!(J)-1)*100 : RETURN
1260 IF ERR=62 AND ERL=1200 AND TYPE><0 THEN LPRINT".LAB file too short, last is
" NUMBE
1265 IF ERR=62 AND ERL=1200 THEN PRINT".LAB file too short, last is" NUMBE:RESUM
E 1250
1270 IF ERR=53 AND ERL=480 THEN PRINT"no .LAB file": LAB=0 : RESUME 490
1280 ON ERROR GOTO 0
1290 '...................................................................
1300 PRINT'...............THIS PORTION DETERMINES LOADS AND ACCUMULATION RATES
1310 PRINT : ON ERROR GOTO 0
1320 '   written by David White and Ian Whillans, The Ohio State University
1330 DIM RUNN(50),CORELEN1(50),CORELEN2(50),DENSITY(50),SAMPLE(50),TOTALLOAD1(50
),TOTALLOAD2(50),LOAD1(50),LOAD2(50)
1340 CLOSE#2 : CLOSE#1 : OPEN "c:\cores\"+FILE1$+".dep" FOR INPUT AS #1
1350 PRINT "ensure that SEL light on printer is illuminated"
1360 PRINT:TOTALLOAD1(0)=0:TOTALLOAD2(0)=0:I=0
1370 WHILE NOT EOF(1) : I=I+1
1380 INPUT#1,RUNN(I),CORELEN1(I),CORELEN2(I),DEPTH1(I),DEPTH2(I),DENSITY(I),SAMP
LE(I) : WEND : ILAST=I : CLOSE#1
1390 '   recovers from the first part of program: run #,2 values for core length
, 2 values for core depth, density, and the last sample # assigned to each run
1400 FOR I=1 TO ILAST '--------PRELIMINARY CALCULATION LOOP-----------------
1410 CORELEN1(I)=CORELEN1(I)*.01 :CORELEN2(I)=CORELEN2(I)*.01 :DEPTH1(I)=DEPTH1(
I)*.01 : DEPTH2(I)=DEPTH2(I)*.01'coverts data from centimeters to meters
1420 IF I><1 GOTO 1540 ELSE PRINT
1430 PRINT
1440 PRINT"Based upon WISP 1984-1986 field data (The Ohio State University, et a
l.)
1450 PRINT"A calculated MEAN VALUE for SURFACE DENSITY is 379 (kg/m3)
1460 PRINT
1470 IF I>1 THEN GOTO 1540 ELSE DENSITY(1)=DENSITY(2):PRINT"ENTER A SURFACE DENS
ITY (in kg/m3) or ENTER A NULL LINE to use";:PRINT USING"#### "; DENSITY(1);:INP
UT"(THE DENSITY OF THE FIRST RUN) ",ANSWER
1480 '          assigns the density of run #1 to the core lost above first sample
1490 PRINT: IF ANSWER >0 THEN DENSITY(1)=ANSWER
1500 '   allows the user to assign a density to the core lost above 1st sample
1510 TEXT$="user supplied":IF ANSWER=0 THEN TEXT$="density of run#1"
1520 PRINT "a surface density of ";:PRINT USING "###.#" ;DENSITY(1);:PRINT" kg/m
3  ("TEXT$") ";"was applied to the ";:PRINT USING" #.###";CORELEN1(1),CORELEN2(1
);:PRINT" m of core loss inserted above the first sample."
1530 IF TYPE><0 THEN LPRINT TAB(INDENT) "a surface density of ";:LPRINT USING "#
##.#" ;DENSITY(1);:LPRINT" kg/m3  ("TEXT$") ";"was applied to the " TAB(INDENT);
:LPRINT USING" #.###";CORELEN1(1),CORELEN2(1);:LPRINT" m of core loss inserted a
bove the first
1540 IF DENSITY(I)>0 GOTO 1610 ELSE DENSITY(I)=(DENSITY(I-1)+DENSITY(I+1))/2
1550 '  assigns the average density of the run above and below to the lost core
1560 IF DENSITY(I+1)=0 THEN DENSITY(I)=DENSITY(I-1)
1570 '          assigns the previous run's density to the inserted core loss
1580 IF DENSITY(I-1)=0 THEN DENSITY(I)=DENSITY(I+1)
1590 '          assigns the following run's density to the inserted core loss
```

```
1600 IF DENSITY(I)=0 THEN LPRINT"can't compute density for i="I : END
1610 LOAD1(I)=DENSITY(I)*CORELEN1(I) : LOAD2(I)=DENSITY(I)*CORELEN2(I) :  TOTALL
OAD1(I)=TOTALLOAD1(I-1)+LOAD1(I) : TOTALLOAD2(I)=TOTALLOAD2(I-1)+LOAD2(I)
1620 '          defines the loads due to the run, and sums the totals
1630 NEXT I '------------------------ TABULATED DATA SUBROUTINE----------------
1640 GOTO 1770 ' this disables the print routine
1650 INPUT"ENTER a number to line-print tabulated core data, otherwise ENTER A N
ULL LINE"; ANSWER:IF ANSWER=0 GOTO 1770 'option to print drilling data
1660 FOR K=1 TO 80 : LPRINT"-";: NEXT K : LPRINT
1670 LPRINT"RUN   CORELENGTH     COREDEPTH    DENSITY  SAMP.    RUNLOAD        T
OTALLOAD":LPRINT" #     L1       L2      D1      D2              #    LOAD1   LOAD2
 TOTAL1   TOTAL2
1680 LPRINT"      (m)    (m)      (m)    (m)     (kg/m2)          (kg/m2)
(kg/m2)
1690 FOR K=1 TO 80 :LPRINT"-";:NEXT K:LPRINT
1700 FOR J=1 TO ILAST
1710 LPRINT USING"##  ";RUNN(J);:LPRINT USING"##.### ";CORELEN1(J),CORELEN2(J) ,
DEPTH1(J),DEPTH2(J) ;:LPRINT USING"  ###.#   ";DENSITY(J);
1720 LPRINT USING"##  ";SAMPLE(J);:LPRINT USING" ####   ";LOAD1(J),LOAD2(J);:LPR
INT" ";
1730 LPRINT USING"  ####  ";TOTALLOAD1(J),TOTALLOAD2(J):NEXT J :LPRINT
1740 LPRINT"############ NOTE: a RUN # of ZERO denotes a coreloss insertion ####
############"
1750 FOR K=1 TO 80 : LPRINT"-";: NEXT K:LPRINT
1760 '--------------------------------------LOAD ROUTINE------------------
1770 'INPUT;"for typed loads and accum rates ENTER a number, otherwise a null li
ne ";TYPE : IF TYPE<>0 THEN TYPE=1
1780 TARGETDEPTH=5!: GOSUB 1840 :LOAD5M=(TTOTALLOAD1 + TTOTALLOAD2)/2
1790 PRINT:INPUT"ENTER THE DEPTH (IN METERS) for the next load : OTHERWISE a nul
l line ",ANSWER
1800 IF ANSWER=0 THEN PRINT"accumulation rates are next" : GOTO 2120
1810 TARGETDEPTH=ANSWER : GOSUB 1840 : GOTO 1790
1820 '########## NOTE: "LOADS" ARE ACTUALLY DEPTH INTEGRATED DENSITIES#########"
1830 PRINT "line1810 reached!":BEEP:IF TYPE=1 THEN LPRINT
1840 FOR J=1 TO ILAST'  loop for load at specified depth (based on depth1)
1850 IF DEPTH1(J) > TARGETDEPTH THEN GOTO 1880
1860 '          compares the current depth(1) against the requested depth
1870 NEXT J : BEEP : PRINT"CORE DOES NOT REACH THE DEPTH OF" TARGETDEPTH" m, MAX
IMUM IS ";:PRINT USING "##.###";DEPTH1(ILAST);:PRINT" m":RETURN
1880 ADDDEPTH1=DEPTH1(J)-TARGETDEPTH
1890 '          determines the amount of the run beyond the target depth
1900 ADDLOAD1=ADDDEPTH1*DENSITY(J)
1910 '          calculates the additional load due to the additional length
1920 TTOTALLOAD1=TOTALLOAD1(J)-ADDLOAD1
1930 '          subtracts the additional load
1940 FOR J=1 TO ILAST'  loop for load at specified depth (based on depth2)
1950 IF DEPTH2(J) > TARGETDEPTH THEN GOTO 2000
1960 '          compares the current depth(2) against the requested depth
1970 NEXT J
1980 IF DEPTH1(ILAST)>DEPTH2(ILAST) THEN MAXIMUM=DEPTH1(ILAST) ELSE MAXIMUM=DEPT
H2(ILAST)'  determines which tally of depth is largest
1990 BEEP: PRINT"CORE DOES NOT REACH THE DEPTH OF" TARGETDEPTH" m, MAXIMUM IS "M
AXIMUM:RETURN
2000 ADDDEPTH2=DEPTH2(J)-TARGETDEPTH
2010 '          determines the amount of the run beyond the target depth
2020 ADDLOAD2=ADDDEPTH2*DENSITY(J)
2030 '          calculates the additional load due to the additional length
2040 TTOTALLOAD2=TOTALLOAD2(J)-ADDLOAD2
2050 '          subtracts the additional load
2060 'IF TTOTALLOAD1=TTOTALLOAD2 GOTO 2080 ............. deleted line
2070 PRINT "at depth of ";:PRINT USING"##.### "; TARGETDEPTH;:PRINT "m, the load
 is within the range of  ";:PRINT USING"#### ";TTOTALLOAD1;:PRINT" and  ";:PRINT
 USING "####";TTOTALLOAD2;:PRINT" kg/m2" : IF TYPE=0 THEN RETURN
2080 IF TYPE=1 THEN LPRINT "at depth =";:LPRINT USING"##.### "; TARGETDEPTH;:LPR
INT "m, the load is in the range ";:LPRINT USING"#### ";TTOTALLOAD1;:LPRINT" to
";:LPRINT USING "####";TTOTALLOAD2;:LPRINT" kg/m2" : RETURN
2090 'PRINT"line 2070 reached!":BEEP'GOTO 2090
2100 'PRINT "at depth of";:PRINT USING "##.###";TARGETDEPTH;:PRINT "M, the load
is ";:PRINT USING "####.##";TTOTALLOAD1 :IF TYPE=0 THEN RETURN
2110 'IF TYPE=1 THEN LPRINT "at depth of";:LPRINT USING "##.###";TARGETDEPTH;:LP
RINT "M. the load is ";:LPRINT USING "####.##":TTOTALLOAD1 :RETURN
```

```
2120 '-------------------------- ACCUMULATION RATE LOOP-------------------------
2130 PRINT : PRINT : PRINT
2140 CLOSE#2 : OPEN "c:\cores\master.cor" FOR APPEND AS #2 :ZERO=0
2150 INPUT"ENTER SAMPLE NUMBER immediately above A BOMB HORIZON OR a null line T
O FINISH   ",BOMBSAMP
2160 PRINT:IF BOMBSAMP=0 THEN GOTO 2490
2170 PRINT"for 1985-86 antarctic cores use 21 years for '64' level and 31 for '5
5'"
2180 PRINT:INPUT"ENTER THE AGE OF THAT BOMB HORIZON (21,30,etc.) OR none TO FINI
SH   ",AGE : IF AGE=0 THEN END
2190 ACCUMRATE1=0 : ACCUMRATE2=0 : PLUSLOAD1=0 :PLUSLOAD2=0
2200 FOR J=1 TO ILAST
2210 IF SAMPLE(J)=BOMBSAMP THEN PRINT"CHOSEN SAMPLE, # "BOMBSAMP ", CORRESPONDS
TO THE END OF RUN # "RUNN(J):JJ=J:PLUSLOAD=0:PLUSLENGTH=0:GOTO 2320
2220 IF SAMPLE(J)> BOMBSAMP GOTO 2260' determines the run # of the bomb sample
2230 NEXT J :IF SAMPLE(ILAST)=0 THEN SAMPLE(ILAST)=SAMPLE(ILAST-1)
2240 PRINT
2250 PRINT"CHOSEN SAMPLE, # "BOMBSAMP"is not valid, last sample in the core is #
"SAMPLE(ILAST) : GOTO 2130
2260 JJ=J-1 : IF SAMPLE(JJ)=0 THEN JJ=J-2 : IF JJ<1 THEN JJ=1
2270  NOSAMPS=SAMPLE(J)-SAMPLE(JJ):LENSAMPS=CORELEN1(J)/NOSAMPS
2280 '        determines the number of samples in the run
2290  SAMPS=BOMBSAMP - SAMPLE(JJ) : PLUSLENGTH=SAMPS*LENSAMPS
2300 '        totals the lengths of those "average" samples
2310  PLUSLOAD=PLUSLENGTH*DENSITY(J)
2320 AVEDEPTH=((DEPTH1(JJ)+DEPTH2(JJ))/2)+PLUSLENGTH
2330 '    computes an estimated value for the depth of the sample
2340 TTOTALLOAD1=TOTALLOAD1(JJ)+PLUSLOAD : TTOTALLOAD2=TOTALLOAD2(JJ)+PLUSLOAD
2350 '        totals the runs' loads and the run's additional load
2360  ACCUMRATE1=(TTOTALLOAD1/920)/AGE : ACCUMRATE2=(TTOTALLOAD2/920)/AGE
2370 '        determines the accumulation rates for the bomb horizon
2380 IF TYPE=1 THEN FOR K=1 TO 80: LPRINT"-";: NEXT K
2390 PRINT"at the "AGE" year old BOMB HORIZON, located at SAMPLE # "BOMBSAMP;:PR
INT", (";:PRINT USING "##.###";AVEDEPTH;:PRINT" m in depth)"
2400 IF TYPE=1 THEN LPRINT TAB(INDENT) "at the "AGE" year level, located at SAMP
LE # "BOMBSAMP;:LPRINT", (";:LPRINT USING "##.###";AVEDEPTH;:LPRINT" m depth)";
2410 PRINT"the LOAD is within the range of: ";:PRINT USING"####";TTOTALLOAD1;:PR
INT" kg/m2  AND ";:PRINT USING"####";TTOTALLOAD2;:PRINT" kg/m2"
2420 IF TYPE=1 THEN LPRINT TAB(INDENT) "the LOAD is in the range of: ";:LPRINT U
SING"####";TTOTALLOAD1;:LPRINT" AND ";:LPRINT USING"####";TTOTALLOAD2;:LPRINT" k
g/m2"
2430 PRINT "ACCUMULATION RATE is within the range of  ";:PRINT USING"#.### ";ACC
UMRATE1;: PRINT" m/yr  and  ";:PRINT USING"#.### ";ACCUMRATE2 ;:PRINT" m/yr";:PR
INT"(FOR ICE DENSITY = 920 kg/m3)"
2440 IF TYPE=1 THEN LPRINT TAB(INDENT) "ACCUMULATION RATE is in the range ";:LPR
INT USING"#.### ";ACCUMRATE1;: LPRINT" to ";:LPRINT USING"#.### ";ACCUMRATE2 ;:L
PRINT" m/yr" :LPRINT TAB(INDENT) "(FOR ICE DENSITY = 920 kg/m3)"
2450 INPUT;"to add these data to a master file enter a number, else a null";ANS
2460 IF ANS>0 THEN WRITE#2,FILE1$,SITE$,LOAD5M,AGE,BOMBSAMP,AVEDEPTH,ACCUMRATE1,
ACCUMRATE2,ZERO,ZERO,ZERO,ZERO,ZERO,ZERO,ZERO,ZERO,ZERO,DATE$
2470 'IF TYPE=1 THEN FOR K=1 TO 80: LPRINT"-";: NEXT K
2480 GOTO 2130'------------------------GRAPHICS SUBROUTINE---------------------
2490 INPUT"prepare printer for density profile, & enter a number, or null to ski
p";ANSWER : IF ANSWER=0 THEN GOTO 2610
2500 DENSCALE=.2 : DEPTHSCALE=7! : LASTDEPTH%=1 : DENSOFF=6
2510 'DENSCALE=.1 : DEPTHSCALE=5! : LASTDEPTH%=1 : LPRINT CHR$(27);CHR$(54);CHR$
(30) ' for Henry's printer
2520 LPRINT TAB(90) "Density profile for 1st depth model" TAB(400*DENSCALE+DENSO
FF);:FOR I=1 TO 200*DENSCALE : LPRINT CHR$(95);:NEXT I
2530 LPRINT TAB(400*DENSCALE+DENSOFF) CHR$(179) " 400" TAB(600*DENSCALE+DENSOFF)
 CHR$(179) " 600"
2540 FOR I=1 TO ILAST : LINEDEPTH%=DEPTH1(I)*DEPTHSCALE
2550 FOR LI=LASTDEPTH% TO LINEDEPTH%
2560 DEPTHR=LI/DEPTHSCALE : TICK =ABS(DEPTHR-FIX(DEPTHR)) :DEPTH%=DEPTHR
2570 LPRINT TAB(DENSITY(I)*DENSCALE+DENSOFF) CHR$(179);
2580 IF TICK <.1 THEN LPRINT TAB(125) DEPTH% TAB(130) "-" ELSE LPRINT
2590 NEXT LI : LASTDEPTH%=LINEDEPTH%+1
```

```
2600 NEXT I '............................ screen graph next
2610 ON ERROR GOTO 2620 :SCREEN 2,0,0 : KEY OFF : LASTDENSITY=0 :GOTO 2630
2620 IF ERR=5 AND ERL =2640 THEN PRINT"need to use HBAS rather that BASICA to ob
tain graphics":END
2630 YSCALE=20:XSCALE=.5:XOFF=0:YOFF=14:DEPTH1(0)=0 : FOR I=1 TO ILAST
2640 LINE(DENSITY(I-1)*XSCALE+XOFF,DEPTH1(I-1)*YSCALE+YOFF)-(DENSITY(I)*XSCALE+X
OFF,DEPTH1(I-1)*YSCALE+YOFF)
2650 LINE(DENSITY(I)*XSCALE+XOFF,DEPTH1(I-1)*YSCALE+YOFF)-(DENSITY(I)*XSCALE+XOF
F,DEPTH1(I)*YSCALE+YOFF)
2660 IF RUNN(I)>0 GOTO 2690' next two lines draw a cross at sites of core loss
2670 LINE(DENSITY(I)*XSCALE+XOFF-80,DEPTH2(I-1)*YSCALE+YOFF)-(DENSITY(I)*XSCALE+
XOFF-55,DEPTH2(I)*YSCALE+YOFF)
2680 LINE(DENSITY(I)*XSCALE+XOFF-55,DEPTH2(I-1)*YSCALE+YOFF)-(DENSITY(I)*XSCALE+
XOFF-80,DEPTH2(I)*YSCALE+YOFF)
2690 NEXT I : LINE(XOFF,YOFF)-(XOFF+500*XSCALE,YOFF)
2700 LINE(XOFF+50,YOFF+(DEPTH2(JJ)+PLUSLENGTH)*YSCALE)-(XOFF+300*XSCALE,YOFF+(DE
PTH2(JJ)+PLUSLENGTH)*YSCALE) : PRINT" bomb"' draw a line at the bomb
2710 LINE(XOFF+275*XSCALE,YOFF+(DEPTH2(JJ)-.5+PLUSLENGTH)*YSCALE)-(XOFF+300*XSCA
LE,YOFF+(DEPTH2(JJ)+PLUSLENGTH)*YSCALE)' add an arrowhead
2720 LINE(XOFF+275*XSCALE,YOFF+(DEPTH2(JJ)+.5+PLUSLENGTH)*YSCALE)-(XOFF+300*XSCA
LE,YOFF+(DEPTH2(JJ)+PLUSLENGTH)*YSCALE)
2730 LINE(XOFF,YOFF)-(XOFF,YOFF+10*YSCALE)
2740 FOR I=1 TO 10 : LINE(XOFF,YOFF+I*YSCALE)-(XOFF+10,YOFF+I*YSCALE) : NEXT I
2750 FOR I=0 TO 500 STEP 100 : LINE(XOFF+I*XSCALE,YOFF)-(XOFF+I*XSCALE,YOFF+10)
: NEXT I
2760 LOCATE 1,1 : FOR I=100 TO 500 STEP 100 :PRINT USING "######";I;: NEXT I
2770 XOFF=300:DEPTH2(0)=0 : FOR I=1 TO ILAST'------ depth2: -----------
2780 LINE(DENSITY(I-1)*XSCALE+XOFF,DEPTH2(I-1)*YSCALE+YOFF)-(DENSITY(I)*XSCALE+X
OFF,DEPTH2(I-1)*YSCALE+YOFF)
2790 LINE(DENSITY(I)*XSCALE+XOFF,DEPTH2(I-1)*YSCALE+YOFF)-(DENSITY(I)*XSCALE+XOF
F,DEPTH2(I)*YSCALE+YOFF)
2800 NEXT I : LINE(XOFF,YOFF)-(XOFF+500*XSCALE,YOFF)' density axis
2810 LINE(XOFF,YOFF)-(XOFF,YOFF+10*YSCALE)' depth axis
2820 FOR I=1 TO 10 : LINE(XOFF,YOFF+I*YSCALE)-(XOFF+10,YOFF+I*YSCALE) : NEXT I
2830 LOCATE 1,28 : FOR I=0 TO 500 STEP 100 :PRINT USING "######";I;: NEXT I
2840 FOR I=0 TO 500 STEP 100 : LINE(XOFF+I*XSCALE,YOFF)-(XOFF+I*XSCALE,YOFF+10)
: NEXT I' tick marks along density axis
2850 FOR I=0 TO 10 :ROW = I*2+2 :LOCATE ROW,31 : PRINT USING "##";I : NEXT
2860 LOCATE 20,5 : PRINT FILE$ :LOCATE 21,5:INPUT"ENTER to exit";DUMMY:SYSTEM
2870 ' CORE4 version 870623
```

XI. REREFERENCES

Hughes, T. 1973. Is the West Antarctic Ice Sheet Disintegrating ?. Journal of geophysical Research, V. 78, No. 33,p. 7784-7909

Mercer, J. 1976. Antarctic Ice and Sangamon Sea Level International Association of Hydrological Sciences, V. 79, p. 217-225

Rose, K. E. 1979. Characteristics of ice flow in Marie Byrd Land, Anarctica. Journal of Glaciology, Vol. 24, No. 90, p. 65-75.

Thomas, R.H. and C.R. Bentley. 1978. A Model for Holocene Retreat of the West Antarctic Ice Sheet. Quaternary Research, V. 10, P. 150-170

Whillans, I.M. and R. Bindschadler. in press. Mass Balance of Ice Stream B. Annals of Glaciology, Vol. II (Bremerhaven meeting, 1987)

Whillans, I.M. and J. Bolzan. 1987. submitted. A method for calculating SIPRE core depths. Journal of Glaciology

XII. FIGURES

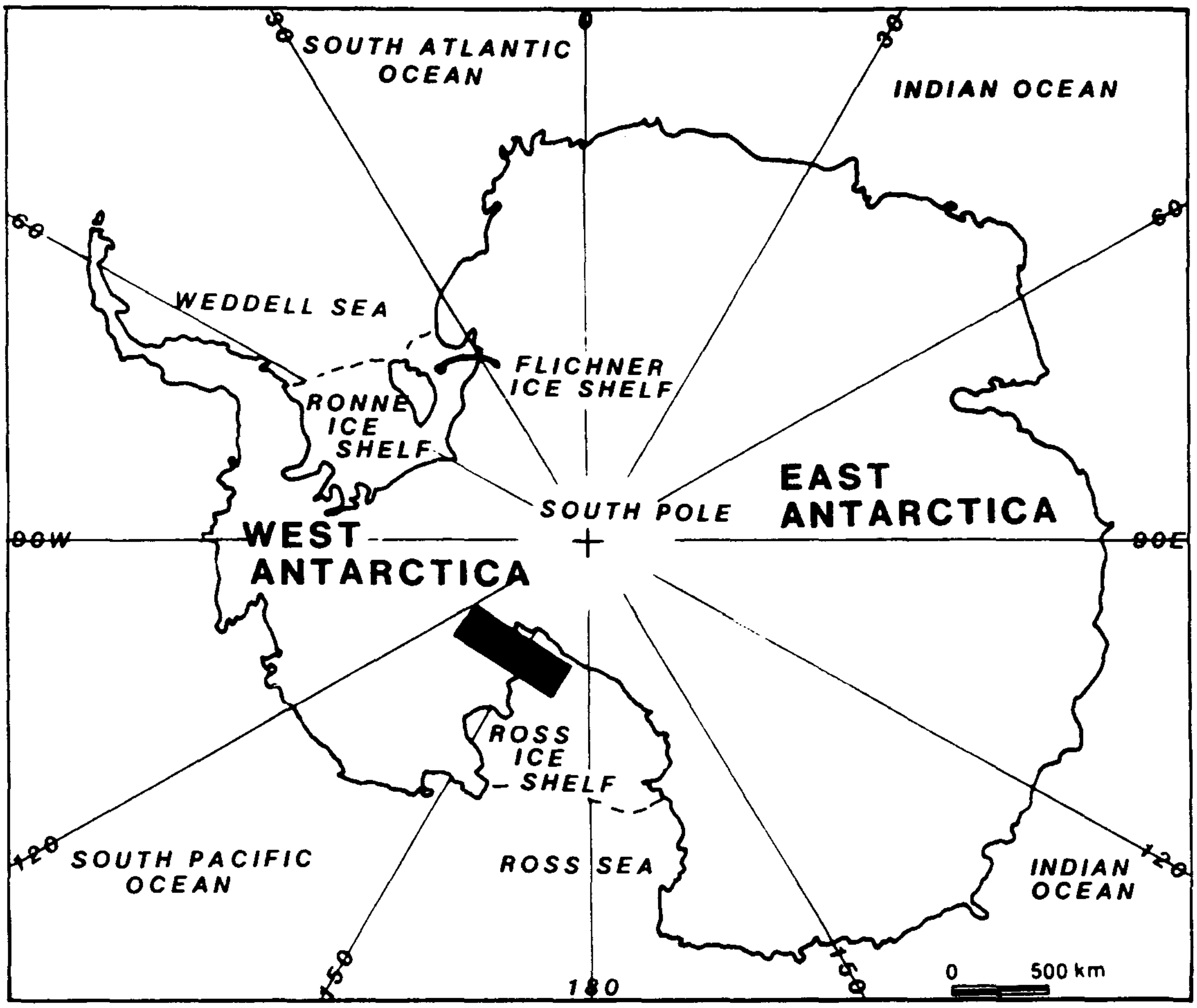


Figure 1. Map of Antarctica showing the general location of the (W.I.S.P.) mass balance project (shaded region) in Marie Byrd Land, West Antarctica.

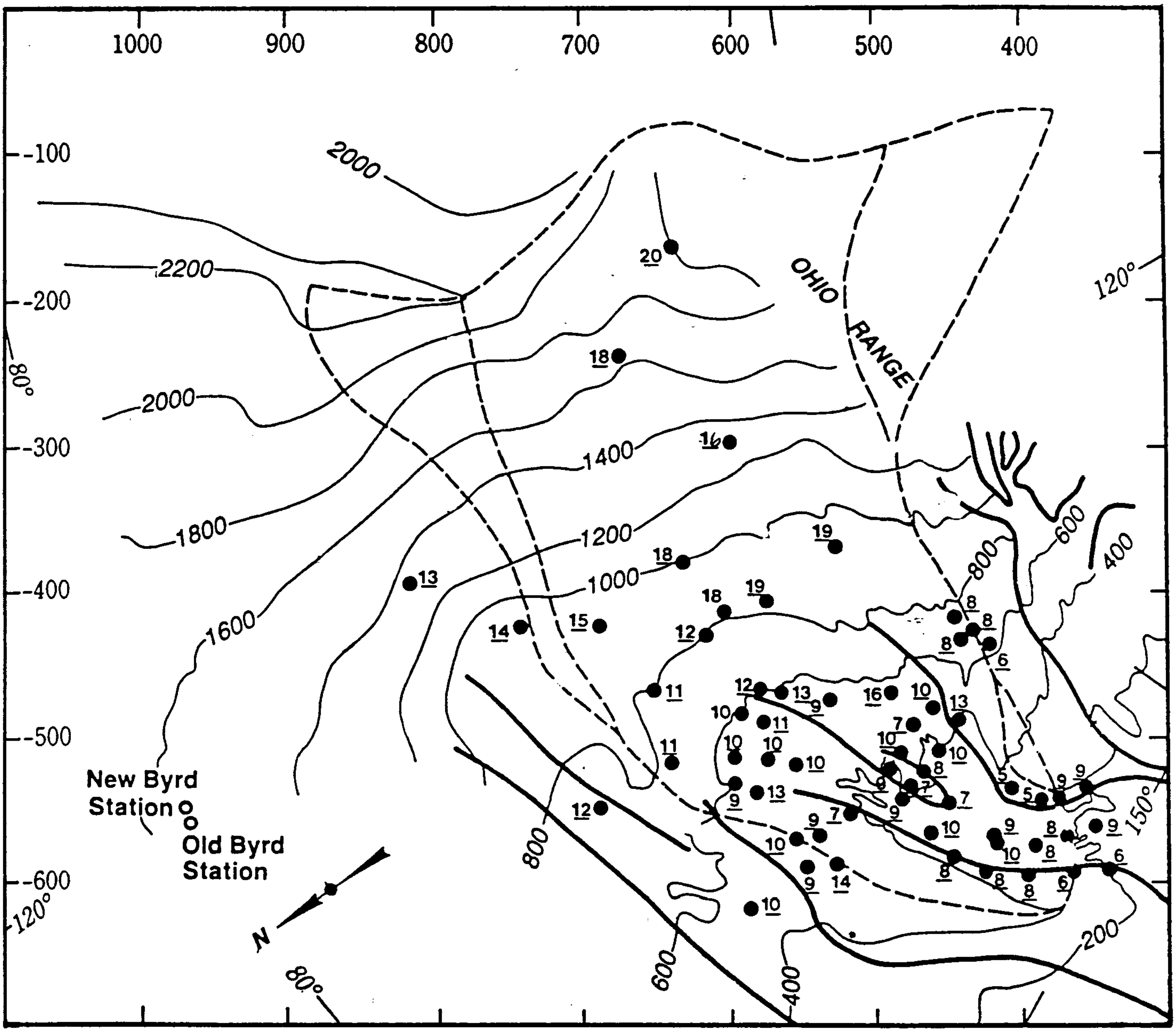
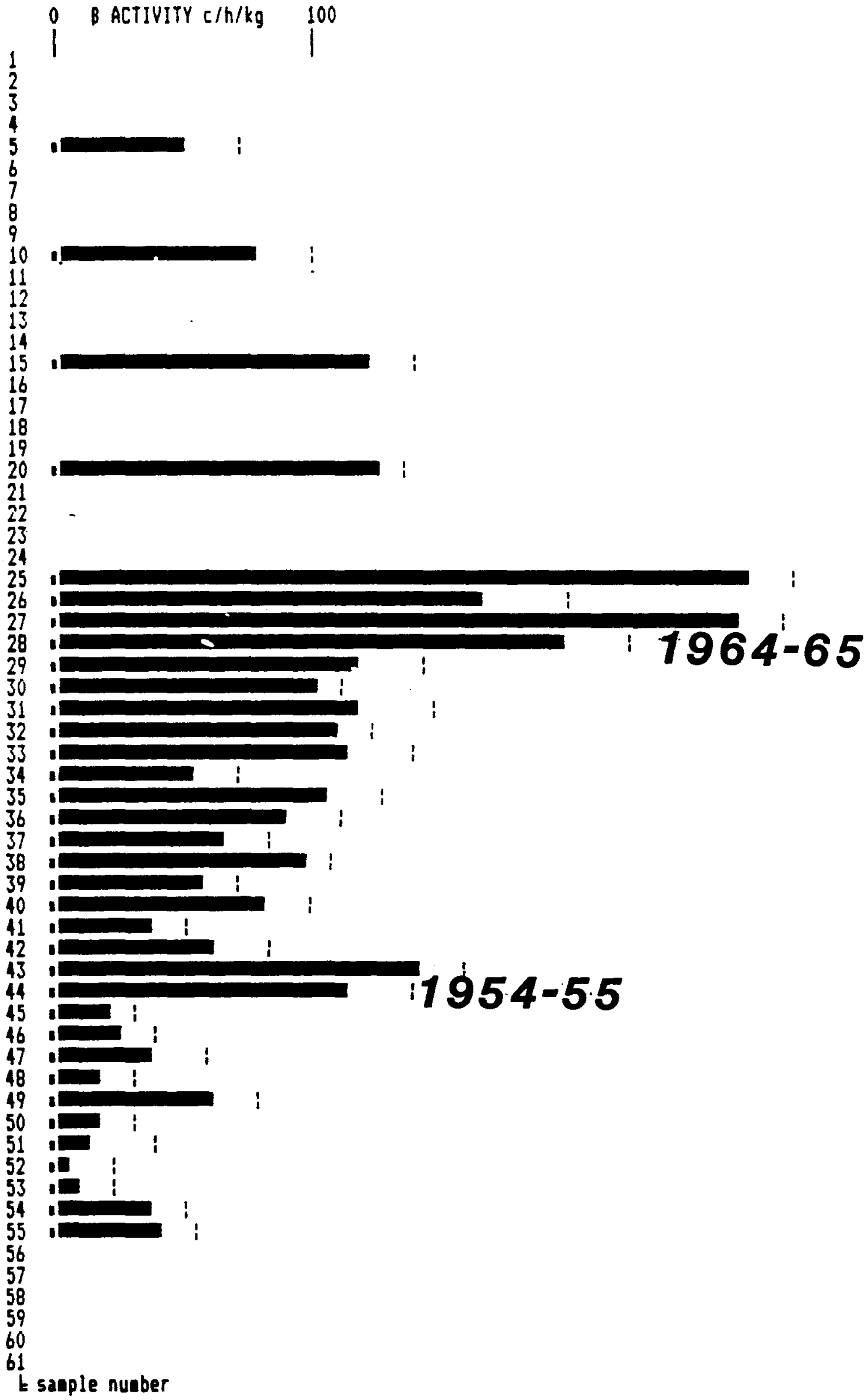
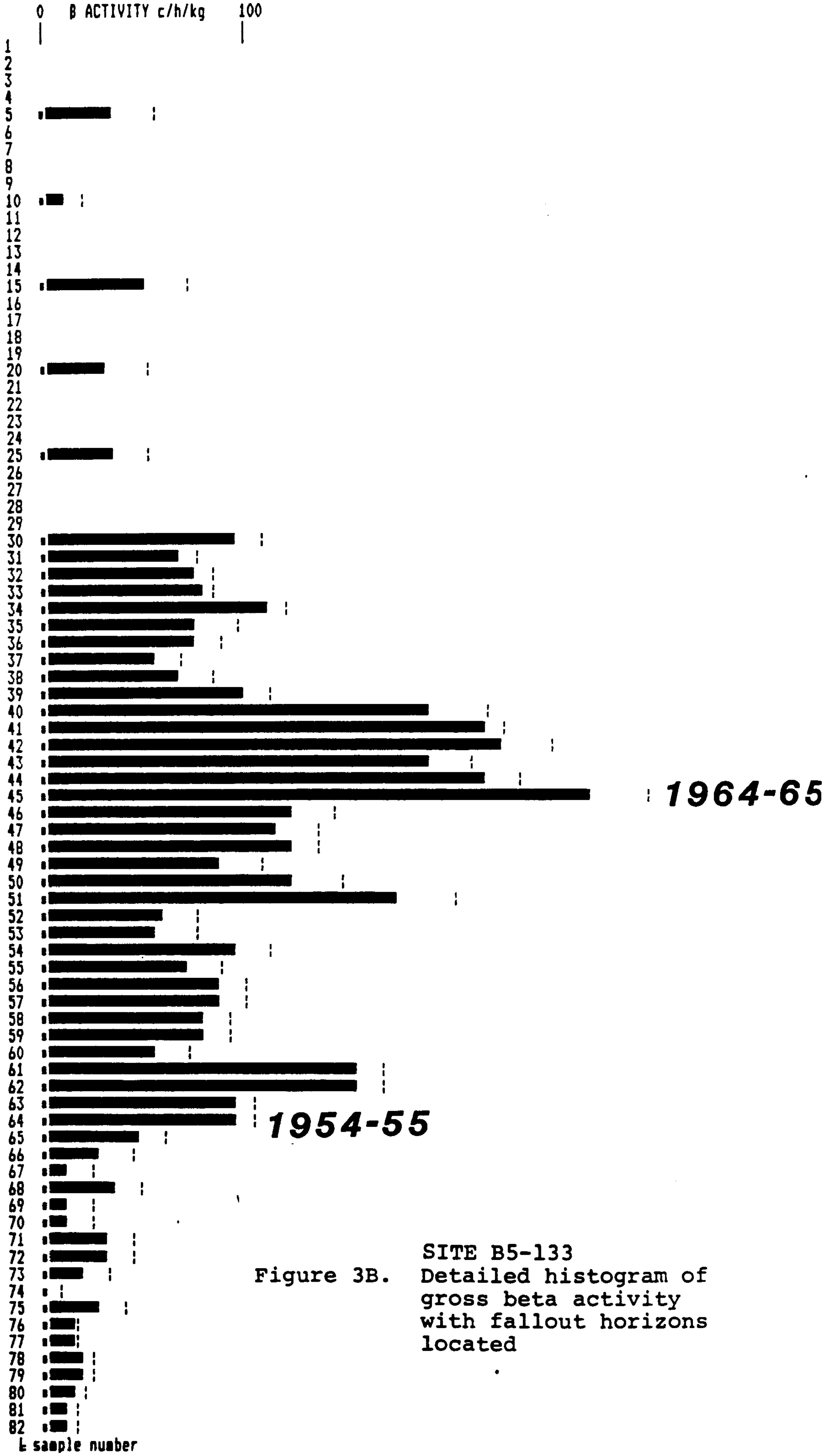


Figure 2. Detailed map of the (W.I.S.P.) project area in Marie Byrd Land, West Antarctica Showing ice stream boundaries, ice core sampling sites and the net ice accumulation rate for those sites (centimeters/yr.)



SITE B5-63

Figure 3A. Detailed histogram of gross beta activity with fallout horizons located.



SITE B5-133

Figure 3B. Detailed histogram of gross beta activity with fallout horizons located

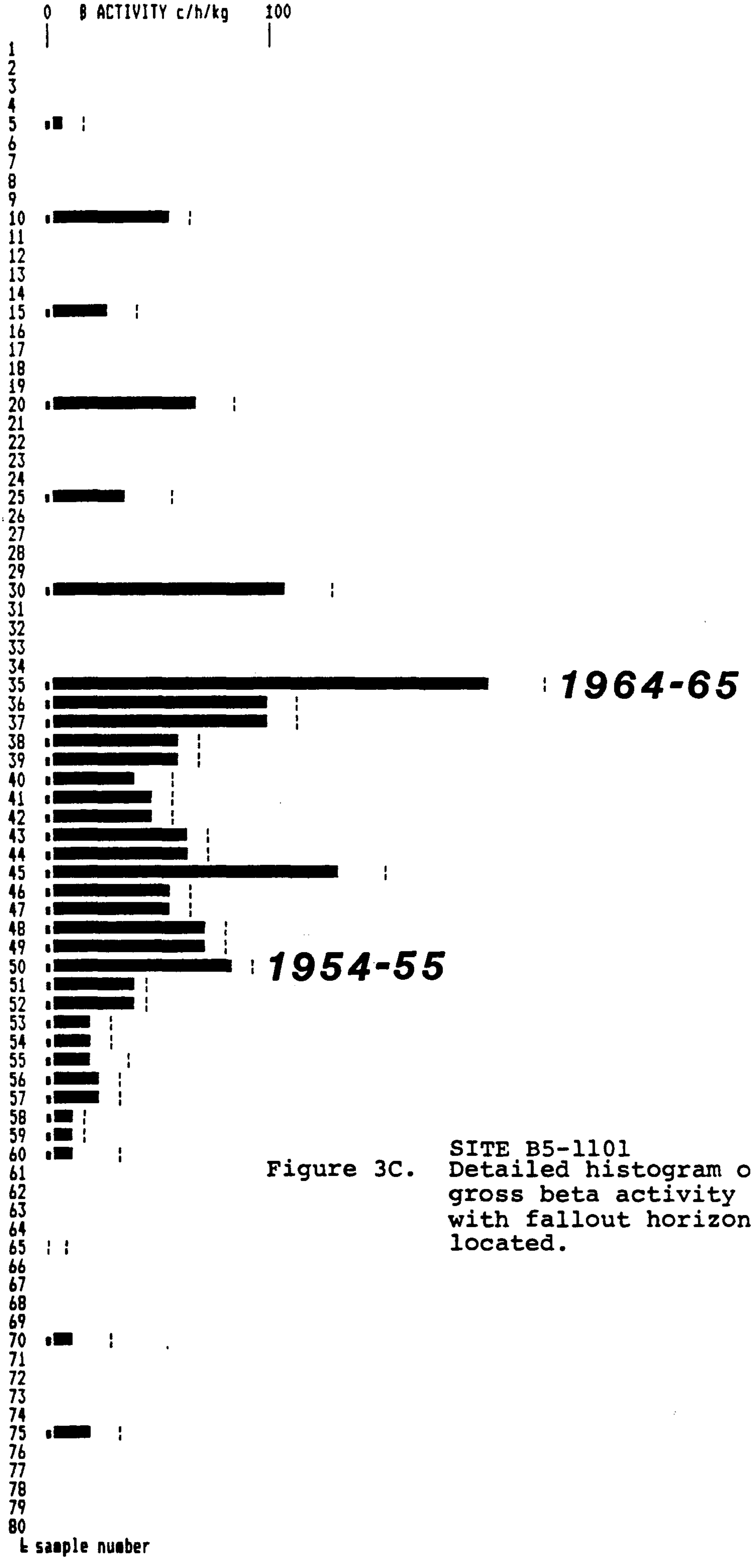


Figure 3C. SITE B5-1101
Detailed histogram of gross beta activity with fallout horizons located.

XIII. TABLES

file =b5-63.lab
comment:b5-63, typed on 05-16-1986, background = .7
today's date: 11-24-1987

numb	length	mass	diam	density	page	M	counts	c/h/kg	1-sigma
5	0.0	168.3	76	0.000	86-17	3145	264	50	25
10	11.0	198	76	0.397	86-17	2588	248	78	24
15	12.0	223.3	76	0.410	86-17	2665	306	120	22
20	11.5	206.3	76	0.395	86-17	8888	1005	125	13
25	10.0	177.9	76	0.392	86-17	6123	918	270	20
26	9.5	163.2	76	0.379	86-37	1824	210	166	37
27	10.0	191.9	76	0.423	86-37	5944	924	267	19
28	9.8	193.3	76	0.435	86-37	2387	320	199	29
29	8.5	174.6	76	0.453	86-36	3140	329	120	26
30	9.0	177.5	76	0.435	86-17	12623	1267	103	12
31	9.5	171	76	0.397	86-36	2203	228	118	31
32	8.8	181	76	0.453	86-36	6061	625	110	18
33	9.5	185.9	76	0.431	86-36	2366	249	114	28
34	10.6	261.7	76	0.544	86-37	2374	222	54	19
35	10.1	224.1	76	0.489	86-17	2727	300	107	22
36	10.5	226.8	76	0.476	86-37	1894	196	89	25
37	11.0	220.3	76	0.441	86-37	2128	199	64	24
38	10.8	247.7	76	0.506	86-37	7386	820	99	12
39	11.0	240.4	76	0.482	86-37	3808	357	59	16
40	12.0	247	76	0.454	86-17	2511	260	81	20
41	12.4	265.6	76	0.472	86-20	2452	211	36	18
42	10.0	219.3	76	0.483	86-20	2170	200	61	24
43	8.5	165.7	76	0.430	86-20	5747	630	143	20
44	8.4	174.7	76	0.458	86-20	2270	233	112	30
45	9.8	205.7	76	0.463	86-17	10002	778	23	11
46	9.0	202	76	0.495	86-23	6210	488	25	15
47	9.2	190.1	76	0.455	86-23	2482	203	37	25
48	10.0	223.1	76	0.492	86-23	3013	230	17	19
49	11.0	228.7	76	0.458	86-23	3478	327	63	18
50	9.3	209.7	76	0.497	86-17	5989	458	19	14
51	8.2	177.9	76	0.478	86-30	2656	198	15	25
52	9.5	219.3	76	0.509	86-30	3056	221	6	19
53	9.5	229.3	76	0.532	86-30	5107	378	11	14
54	9.8	223.3	76	0.502	86-30	4347	363	36	16
55	9.5	210.8	76	0.489	86-17	6462	552	44	14

Table 1A. LAB3 program output - Laboratory an beta activity counting data.

file =b5-133.lab
comment:b5-133, typed on 05-05-1986, background = .71
today's date: 11-24-1987

numb	length	mass	diam	density	page	M	counts	c/h/kg	1-sigma
5	0.0	160.1	76	0.000	86-14	3850	308	34	23
10	16.0	297	76	0.409	86-14	4463	339	10	12
15	0.0	207.2	76	0.000	86-14	2400	211	49	24
20	10.4	189.1	76	0.401	86-14	2783	224	30	23
25	11.4	241.7	76	0.467	86-14	2590	221	36	19
30	13.0	278.1	76	0.472	86-14	3008	342	92	17
31	14.0	273.9	76	0.431	87-11	8754	888	67	10
32	13.5	292.3	76	0.477	87-11	3430	364	72	15
33	13.6	297	76	0.481	87-11	9020	988	78	9
34	11.0	281.1	76	0.563	87-11	8199	1012	112	10
35	11.2	235.4	76	0.463	86-14	2525	254	75	21
36	10.3	247.6	76	0.530	87-11	3107	313	72	18
37	14.0	317.4	76	0.500	87-11	2047	202	52	17
38	12.7	279.8	76	0.486	87-11	2239	228	66	19
39	13.5	303	76	0.495	87-11	2509	301	97	17
40	11.2	260.4	76	0.513	86-14	1310	202	192	30
41	11.0	262.2	76	0.525	87-03	8938	1481	217	12
42	11.2	242	76	0.476	87-03	1567	253	224	30
43	12.0	260.2	76	0.478	87-03	2368	365	192	22
44	6.1	129.4	76	0.468	87-03	8034	946	217	22
45	11.4	267.7	76	0.518	86-14	1380	264	270	31
46	10.9	240.5	76	0.486	86-19	1653	197	120	27
47	10.7	255.7	76	0.527	86-19	1792	213	112	24
48	10.1	237.8	76	0.519	86-19	7490	899	124	13
49	10.2	230.6	76	0.498	86-19	2196	228	85	23
50	10.0	239.2	76	0.527	86-14	1836	220	122	26
51	11.0	258.8	76	0.519	86-21	1383	203	176	29
52	10.0	244.7	76	0.539	86-21	2066	194	56	22
53	11.2	250.5	76	0.493	86-21	2143	202	56	21
54	11.8	287.9	76	0.538	86-21	1787	207	93	21
55	9.1	224.1	76	0.543	86-14	2947	286	70	20
56	19.9	470.3	76	0.521	87-07	1833	255	87	14
57	19.9	470.3	76	0.521	87-07	1833	255	87	14
58	0.0	534.6	76	0.000	87-07	1388	197	80	14
59	0.0	534.6	76	0.000	87-07	1388	197	80	14
60	11.0	263.5	76	0.528	86-14	2119	199	52	20
61	22.3	550.3	76	0.544	87-07	1850	394	155	14
62	22.3	550.3	76	0.544	87-07	1850	394	155	14
63	23.7	570.7	76	0.531	87-07	1813	288	92	12
64	23.7	570.7	76	0.531	87-07	1813	288	92	12
65	11.1	267.4	76	0.531	86-14	3637	333	46	15
66	10.4	247.6	76	0.525	86-30	2425	198	26	19
67	10.3	250.6	76	0.536	86-30	2732	204	9	17
68	10.8	267.9	76	0.547	86-30	3246	281	35	16
69	10.7	270.7	76	0.558	86-30	3039	231	11	15
70	12.2	302.9	76	0.547	86-14	2799	213	10	14
71	12.5	305.2	76	0.538	86-21	2397	209	32	16
72	11.2	288.3	76	0.567	86-21	2347	201	30	17
73	12.1	316.3	76	0.576	86-21	3411	278	20	13
74	12.4	319.2	76	0.567	86-21	10421	758	3	7
75	12.1	305.5	76	0.557	86-14	2591	218	26	15
76	22.8	567	76	0.548	87-13	8752	725	13	4
77	22.8	567	76	0.548	87-13	8752	725	13	4
78	20.8	521.5	76	0.553	87-13	2530	219	18	9
79	20.8	521.5	76	0.553	87-13	2530	219	18	9
80	11.9	295.8	76	0.548	86-14	6256	485	13	10
81	25.0	636.7	76	0.561	87-13	2711	221	10	7
82	25.0	636.7	76	0.561	87-13	2711	221	10	7

Table 1B. LAB3 program output - Laboratory data and beta activity counting data.

file =b5-1101.lab
comment:b5-1101, typed on 05-28-1986, background = .71
today's date: 11-24-1987

numb	length	mass	diam	density	page	M	counts	c/h/kg	1-sigma
5	10.5	178.5	76	0.375	86-26	6992	506	5	15
10	10.3	192	76	0.411	86-26	11112	976	53	12
15	10.0	209	76	0.461	86-26	5589	448	26	15
20	10.1	198.9	76	0.434	86-26	3140	291	65	22
25	8.0	156.6	76	0.432	86-26	3311	263	32	26
30	10.9	239.9	76	0.485	86-26	1968	222	105	24
35	11.0	235.6	76	0.472	86-26	1724	256	197	29
36	19.5	457	76	0.517	87-02	1774	260	99	15
37	19.5	457	76	0.517	87-02	1774	260	99	15
38	20.5	437.6	76	0.471	87-02	2213	252	59	13
39	20.5	437.6	76	0.471	87-02	2213	252	59	13
40	10.3	224.4	76	0.480	86-26	2762	234	37	20
41	19.8	448.8	76	0.500	87-02	2076	216	44	12
42	19.8	448.8	76	0.500	87-02	2076	216	44	12
43	0.0	414	76	0.000	87-02	2130	242	62	13
44	0.0	414	76	0.000	87-02	2130	242	62	13
45	11.3	265.9	76	0.519	86-26	1705	220	131	24
46	0.0	470.9	76	0.000	87-02	1978	226	55	12
47	0.0	470.9	76	0.000	87-02	1978	226	55	12
48	18.9	471.5	76	0.550	87-02	1969	248	70	13
49	18.9	471.5	76	0.550	87-02	1969	248	70	13
50	9.5	240.6	76	0.558	86-26	8138	849	83	12
51	20.0	469.7	76	0.518	86-31	3055	307	38	10
52	20.0	469.7	76	0.518	86-31	3055	307	38	10
53	19.6	436.1	76	0.490	86-31	2590	221	20	11
54	19.6	436.1	76	0.490	86-31	2590	221	20	11
55	9.5	220.8	76	0.512	86-26	2623	205	19	20
56	18.9	486.2	76	0.567	87-03	2890	261	24	9
57	18.9	486.2	76	0.567	87-03	2890	261	24	9
58	0.0	507.5	76	0.000	87-03	3084	247	11	8
59	0.0	507.5	76	0.000	87-03	3084	247	11	8
60	8.5	199.1	76	0.516	86-26	2667	198	10	22
65	10.9	258.5	76	0.523	86-26	7232	490	-8	10
70	9.7	244.1	76	0.555	86-26	2743	207	11	18
75	10.3	261.2	76	0.559	86-26	2907	228	17	16

Table 1C. LAB3 program output - Laboratory data and beta activity counting data.

file: b5-63.cor,   datum: 0 cm
comment: b5-63
data entered on 03-03-1986, CORE3 today's date: 11-24-1987

drill length	exposed portion	recovered core	mass	drill depth	apparent	core loss	run	deepest samp No	diam
				0.0		0.0			
204.0	45.0	156.0	2911.0	159.0	3.0	3.0	1	0	3000
205.5	0.0	22.0	372.0	205.5	24.5	27.5	2	2	2800
305.5	55.0	52.0	917.0	250.5	-7.0	20.5	3	6	2900
305.5	40.0	34.0	638.0	265.5	-19.0	1.5	4	9	2900
405.5	67.0	55.5	1010.0	338.5	17.5	19.0	5	14	2900
405.5	10.0	57.0	1094.0	395.5	0.0	19.0	6	19	2915
505.5	50.0	56.0	1077.0	455.5	4.0	23.0	7	24	2915
505.5	52.0	0.0	0.0	453.5	-2.0	21.0	8	0	2915
505.5	2.0	51.0	945.0	503.5	-1.0	20.0	9	29	2915
605.5	63.0	39.5	778.0	542.5	-0.5	19.5	10	33	2915
605.5	60.0	0.0	0.0	545.5	3.0	22.5	11	0	2915
605.5	5.0	57.0	1270.0	600.5	-2.0	20.5	12	38	2915
705.5	74.0	37.0	830.0	631.5	-6.0	14.5	13	41	2915
705.5	32.0	39.0	832.0	673.5	3.0	17.5	14	45	2915
805.5	97.0	40.5	880.0	708.5	-5.5	12.0	15	49	2915
805.5	66.0	29.0	654.0	739.5	2.0	14.0	16	52	2915
805.5	30.0	40.0	946.0	775.5	-4.0	10.0	17	56	2915

automatic special runs selected : 17 4 0
depth to top of first recovered core sample 0

corrected depth of core base	drill depth	core length	run	sample number	density	% larger for LAB masses
1.5 0.0	1.5 to 0.0 cm of core loss					
157.5 - 156.0	159.0	156.0	1	0	409.2	0.0
179.5 - 178.0	205.5	22.0	2	2	425.6	0.0 ?
231.5 - 230.0	250.5	52.0	3	6	413.8	0.0 ?
265.5 - 264.0	265.5	34.0	4	9	440.3	0.0 ?
274.0 265.5	8.5 to 1.5 cm of core loss					
329.5 - 321.0	338.5	55.5	5	14	427.0	0.0
386.5 - 378.0	395.5	57.0	6	19	445.8	0.0
442.5 - 434.0	455.5	56.0	7	24	446.7	0.0
442.5 - 434.0	453.5	0.0	8	0	0.0	0.0
493.5 - 485.0	503.5	51.0	9	29	430.4	-4.7
533.0 - 524.5	542.5	39.5	10	33	457.5	-8.0
533.0 - 524.5	545.5	0.0	11	0	0.0	0.0
590.0 - 581.5	600.5	57.0	12	38	517.5	-7.0
627.0 - 618.5	631.5	37.0	13	41	521.0	-9.3
666.0 - 657.5	673.5	39.0	14	45	495.5	-8.0
706.5 - 698.0	708.5	40.5	15	49	504.7	-4.1
735.5 - 727.0	739.5	29.0	16	52	523.8	-7.2
775.5 - 767.0	775.5	40.0	17	56	549.3	0.0
775.5 775.5	0.0 to 8.5 cm of core loss					

a surface density of 409.2 kg/m3 (density of run#1) was applied to the 0.015 0.000 m of core loss inserted above the first
at depth = 5.000 m, the load is in the range 2130 to 2133 kg/m2

---

at the 21 year level, located at SAMPLE # 28 , (4.790 m depth)
the LOAD is in the range of: 2057 AND 2020 kg/m2
ACCUMULATION RATE is in the range 0.106 to 0.105 m/yr
(FOR ICE DENSITY = 920 kg/m3)

---

at the 31 year level, located at SAMPLE # 44 , (6.520 m depth)
the LOAD is in the range of: 2914 AND 2877 kg/m2
ACCUMULATION RATE is in the range 0.102 to 0.101 m/yr
(FOR ICE DENSITY = 920 kg/m3)

Table 2A. CORE4 program output - Drilling data and the net ice accumulation rate.

file: b5-133.cor, datum: 60 cm
comment: B5-133
data entered on 06-20-1986, CORE3 today's date: 11-24-1987

drill length	exposed portion	recovered core	recovered mass	drill depth	apparent core loss		run	deepest samp No	diam
				0.0		0.0			
105.0	10.0	86.0	1489.0	95.0	9.0	9.0	1	8	71
205.0	51.0	55.0	1022.0	154.0	4.0	13.0	2	12	75
205.0	0.0	50.6	970.0	205.0	0.4	13.4	3	16	74
305.0	45.0	57.7	1095.0	260.0	-2.7	10.7	4	21	74
305.0	0.0	46.5	914.0	305.0	-1.5	9.2	5	25	74
405.0	52.0	41.4	851.0	353.0	6.6	15.8	6	29	74
405.0	0.0	54.4	1150.0	405.0	-2.4	13.4	7	33	74
505.0	62.0	35.0	777.0	443.0	3.0	16.4	8	36	74.7
505.0	21.0	40.6	918.0	484.0	0.4	16.8	9	39	75
605.0	72.0	46.0	1043.0	533.0	3.0	19.8	10	43	75
605.0	38.0	40.3	908.0	567.0	-6.3	13.5	11	47	75
705.0	100.0	30.8	717.0	605.0	7.2	20.7	12	50	75
705.0	60.0	45.0	1063.0	645.0	-5.0	15.7	13	54	75
705.0	21.0	41.3	991.0	684.0	-2.3	13.4	14	58	75
805.0	76.0	45.0	1102.0	729.0	0.0	13.4	15	62	75
805.0	40.0	36.0	868.0	765.0	0.0	13.4	16	65	75
905.0	100.0	43.0	1060.0	805.0	-3.0	10.4	17	69	74.3
905.0	47.0	48.5	1234.0	858.0	4.5	14.9	18	73	75
905.0	0.0	37.2	949.0	905.0	9.8	24.7	19	76	75
1005.0	77.0	31.4	806.0	928.0	-8.4	16.3	20	79	74.4
1005.0	49.0	37.0	951.0	956.0	-9.0	7.3	21	82	75.7

automatic special runs selected : 21 0
depth to top of first recovered core sample 0

corrected depth of core base	drill depth	core length	run	sample number	density	% larger for LAB masses	
67.3 60.0	67.3 to 60.0 cm of core loss						
153.3 - 146.0	95.0	86.0	1	8	437.3	0.0	?
208.3 - 201.0	154.0	55.0	2	12	429.6	0.0	?
258.9 - 251.6	205.0	50.6	3	16	445.7	0.0	?
316.6 - 309.3	260.0	57.7	4	21	441.2	0.0	?
363.1 - 355.8	305.0	46.5	5	25	457.0	0.0	?
404.5 - 397.2	353.0	41.4	6	29	477.9	0.0	
458.9 - 451.6	405.0	54.4	7	33	491.5	-0.8	
493.9 - 486.6	443.0	35.0	8	36	506.5	-1.7	
534.5 - 527.2	484.0	40.6	9	39	511.8	-1.9	
580.5 - 573.2	533.0	46.0	10	43	513.2	-1.7	
620.8 - 613.5	567.0	40.3	11	47	510.0	-1.6	
651.6 - 644.3	605.0	30.8	12	50	526.9	-1.3	
696.6 - 689.3	645.0	45.0	13	54	534.7	-2.0	
737.9 - 730.6	684.0	41.3	14	58	543.1	24.0	
782.9 - 775.6	729.0	45.0	15	62	554.3	-26.2	?
818.9 - 811.6	765.0	36.0	16	65	545.8	-3.4	
861.9 - 854.6	805.0	43.0	17	69	568.6	-2.2	
910.4 - 903.1	858.0	48.5	18	73	575.9	-1.7	
947.6 - 940.3	905.0	37.2	19	76	577.4	25.6	
979.0 - 971.7	928.0	31.4	20	79	590.4	-35.3	?
1016.0 -1008.7	956.0	37.0	21	82	571.1	-1.9	
1016.0 1016.0	0.0 to 7.3 cm of core loss						

a surface density of 437.3 kg/m3 (density of run#1) was applied to the
0.673 0.600 m of core loss inserted above the first
at depth = 5.000 m, the load is in the range 2268 to 2274 kg/m2

---

at the 21 year level, located at SAMPLE # 45 , (5.970 m depth)
the LOAD is in the range of: 2784 AND 2752 kg/m2
ACCUMULATION RATE is in the range 0.144 to 0.142 m/yr
(FOR ICE DENSITY = 920 kg/m3)

---

at the 31 year level, located at SAMPLE # 64 , (8.032 m depth)
the LOAD is in the range of: 3894 AND 3862 kg/m2
ACCUMULATION RATE is in the range 0.137 to 0.135 m/yr
(FOR ICE DENSITY = 920 kg/m3)

Table 2B. CORE4 program output - drilling data an the net accumulation rate.

file: b5-1101.cor, datum: 208 cm
comment: also called B5-101
data entered on 06-20-1986, CORE3 today's date: 11-24-1987

drill length	exposed portion	recovered core	recovered mass	drill depth	apparent core loss	apparent core loss	run	deepest samp No	diam
				0.0		0.0			
208.5	109.5	86.6	1505.0	99.0	12.4	12.4	1	8	3062
208.5	35.5	73.6	1400.0	173.0	0.4	12.8	2	15	3062
299.5	17.5	113.4	2300.0	282.0	-4.4	8.4	3	26	3105
405.0	23.5	95.0	2022.0	381.5	4.5	12.9	4	35	3113
496.5	16.5	92.0	2020.0	480.0	6.5	19.4	5	44	3000
602.0	39.5	84.5	1946.0	562.5	-2.0	17.4	6	52	3056
695.0	44.0	89.9	2194.0	651.0	-1.4	16.0	7	61	3070
800.5	85.5	60.2	1462.0	715.0	3.8	19.8	8	67	3070
800.5	-1.5	83.7	2090.0	802.0	3.3	23.1	9	75	3065

automatic special runs selected : 9 8 7 4 3 0
depth to top of first recovered core sample 0

corrected depth of core base		drill depth	core length	run	sample number	density	% larger for LAB masses	
216.4	208.0	216.4 to 208.0 cm of core loss						
303.0 -	294.6	99.0	86.6	1	8	365.8	0.0	?
376.6 -	368.2	173.0	73.6	2	15	400.4	0.0	?
490.0 -	481.6	282.0	113.4	3	26	415.2	0.0	
494.5	490.0	4.5 to 8.4 cm of core loss						
589.5 -	585.0	381.5	95.0	4	35	433.5	0.0	?
592.6	589.5	3.1 to 4.5 cm of core loss						
684.6 -	681.5	480.0	92.0	5	44	481.5	-1.9	
769.1 -	766.0	562.5	84.5	6	52	486.7	-1.4	
859.0 -	855.9	651.0	89.9	7	61	511.0	0.0	
862.8	859.0	3.8 to 3.1 cm of core loss						
923.0 -	919.2	715.0	60.2	8	67	508.5	0.0	?
926.3	923.0	3.3 to 3.8 cm of core loss						
1010.0 -	1006.7	802.0	83.7	9	75	524.6	0.0	?
1010.0	1010.0	0.0 to 3.3 cm of core loss						

a surface density of 365.8 kg/m3 (density of run#1) was applied to the
2.164 2.080 m of core loss inserted above the first
at depth = 5.000 m, the load is in the range 1917 to 1922 kg/m2

---

at the 21 year level, located at SAMPLE # 35 , (5.873 m depth)
the LOAD is in the range of: 2305 AND 2291 kg/m2
ACCUMULATION RATE is in the range 0.119 to 0.119 m/yr
(FOR ICE DENSITY = 920 kg/m3)

---

at the 31 year level, located at SAMPLE # 50 , (7.464 m depth)
the LOAD is in the range of: 3070 AND 3063 kg/m2
ACCUMULATION RATE is in the range 0.108 to 0.107 m/yr
(FOR ICE DENSITY = 920 kg/m3)

Table 2C. CORE4 program output - Drilling data and the net accumulation rate.